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# MENDELISM AND THE PROBLEM OF MENTAL DEFECT

II. ON THE CONTINUITY OF MENTAL DEFECT

BY

KARL PEARSON AND GUSTAV A. JAEDERHOLM

WITH FOUR DIAGRAMS

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The problem of the feeble-minded (of whom about two-thirds are degenerates) is a different and greater one than that of the dull children who lag along two or three grades behind in school. There are so many indeterminate borderland cases, however, that the two groups are best studied together under the general caption of mental deficiency.—W. S. CORNELL, M.D.

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# ON THE CONTINUITY OF MENTAL DEFECT

## (I) INTRODUCTORY.

ONE of the great difficulties attending legislation for the segregation of the mentally defective lies in the need for an adequate definition of 'mental defect'. Medical men and workers who have had experience of mentally defective children have long been accustomed to make broad classifications of the mentally defective. These classifications are based partly on mental and partly on moral characters, and frequently turn as much on temperament as on actual intelligence. The publication of the Binet-Simon method of testing intelligence placed before psychologists a new method of measuring mental defect purely from the standpoint of intelligence, and apart from problems of defective self-control or of bad moral or personal habits. The result of investigations of this nature shows a very wide range of continuous grades of intelligence possessed by children classed as 'mentally defectives'. In view of such a result as this, it is very hard to grasp what the American students of genetics understand when they speak of mental defect as a 'unit character', and assert that it is a Mendelian 'recessive'. This difficulty of appreciation is intensified by the fact that these American investigators appear to have made no attempt to measure psychologically the extent of feeble-mindedness in either offspring or parents, but tell us that feeble-mindedness comprises various mental deficiencies, such as inability to count, to repeat phrases, to learn to write or to draw, to meet difficult situations by intelligent adjustment, to control the appetites and passions, to appreciate moral ideas. Many persons have, according to Dr. Davenport,<sup>1</sup> *some* of these or similar defects; the typically feeble-minded are defective in *several or many* such mental traits. How these writers distinguish between *some* and *several* is by no means clear, and the whole conception is of far too slender a nature to bear the imposing superstructure of 'mental defect' as a recessive Mendelian unit-character, which has been based thereon.

<sup>1</sup> *Heredity and Eugenics*, University of Chicago Press, 1912, p. 280.

The only rational method of investigation is to start an inquiry on the widest basis possible of the nature of mental defect in those children who have been transferred to special classes or schools on the ground of their feeble-mindedness. Such a quantitative inquiry has been made on upwards of 300 mentally defective children in the schools of Stockholm by one of the present writers. He has applied tests of the Binet-Simon type to these children and used as control similar tests to measure the mental grade of over 250 normal children. In Stockholm in 1911<sup>1</sup> there were 25,168 children in the public elementary schools, distributed as follows :

Under 7 years	92 = 0.4 per cent.	
7 years old	3,481 = 13.8	„
8 years old	3,661 = 14.6	„
9 years old	3,800 = 15.1	„
10 years old	3,494 = 13.9	„
11 years old	3,503 = 13.9	„
12 years old	3,191 = 12.7	„
13 years old	2,882 = 11.4	„
14 years old	962 = 3.8	„
Over 14 years	102 = 0.4	„
	<hr/> 25,168	

In addition there are 209 children of 13, 112 of 14, and 10 over 14 in continuation schools, so that we have a total of 25,499 children in what are practically public elementary schools. These form 76.6 per cent. of the children of these ages. But at the ages 9 to 10, about 200 boys each year are, chiefly on the ground of their ability, partly on economic grounds, drafted into 'Vorgymnasia'. There are no such State schools for girls as yet, but about 100 girls are annually transferred to private schools. This transfer is believed to be largely on economic grounds, and the examination for transfer is not so severe as in the case of the entrance examination for the 'Vorgymnasia'. 200 boys drafted between 9 and 10 from the elementary schools would signify a total loss (years 10 to 14) of not more than 1,000 boys; the girl loss would be about 500. Now we know that some 76.6 per cent. of the children of Stockholm are in the elementary public schools, and these children number 25,499. This, therefore, provides us with a total school population of 33,249. But we also are told that 6.7 per cent. of the children are in 'Vorgymnasia';

<sup>1</sup> The nearest statistics available for comparison with those of the year of investigation, 1912.

hence we should anticipate that 2,228 boys are in these schools. Of these boys, accordingly, rather less than half proceeded from the public elementary schools.<sup>1</sup> Private schools absorb 14·4 per cent. of the Stockholm children. Thus we have accounted for 97·6 per cent. of the children of school age. Another ·2 per cent. of the children are at special centres<sup>2</sup> for abnormal children. These are designed for those who cannot in any way profit by the instruction in the ordinary schools; they are generally physically defective, and the majority consist of blind children. ·2 per cent. of 33,249 provides only 66 children. Of these, 12 children, without being idiots or imbeciles, are of such low intelligence that they cannot be dealt with in the 'help-classes'. Assuming these 12 children to be provided by the public elementary school population, they contribute only ·04 per cent. to the mentally defective total. The 2·1 per cent. of children remaining of the Stockholm population of school age were presumably either taught at home, in asylums of one type or another, or for some reason are not as yet at school.<sup>3</sup>

The bulk of the mentally defective children of Stockholm are provided for in what are termed 'help-classes'. These contained in 1912 about 320 mentally defective children; of whom, one of the present authors was able to test no less than 301 individuals. These did not include the 12 cases of defective intelligence at the special centres referred to above. Together, we have a population of about 332 mentally defective children corresponding to the total school population of Stockholm, which, however, we must limit to the range of children from which they are drawn. These may be enumerated as follows:—

Children in public elementary schools, including the 'help-classes' . . . . .	25,499
Boys drafted from these to 'Vorgymnasia', say . . .	1,000
Girls drafted from these to private schools, say . . .	500
Children at special centres . . . . .	66
Total, say . . . . .	27,065

<sup>1</sup> Actually it is reckoned that only about 45 per cent. of the children in the 'Vorgymnasia' have passed through the elementary schools. The remainder come from private schools. As a rule, the elementary school children in the 'Vorgymnasia' are about a year behind the children of the parents who can afford to send them to the private schools.

<sup>2</sup> The term 'special centre' instead of 'special school' has been used, for the scope seems more limited than that of the special schools in England, where provision is also made for the bulk of the mentally defective, who are dealt with in Sweden in the 'help-classes'.

<sup>3</sup> School can only be entered now once (formerly twice) a year, so that a child may be 7 and not yet able to start school.

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Thus a total of 332 mentally defective boys and girls appear to be drawn from a population of 27,065 children = 1.23 per cent. This is rather a larger percentage than we find in Liverpool, but less than in London :

Liverpool : Boys, .827 per cent. ; girls, .618 per cent.

Mean : .725 per cent.

London : Boys, 1.59 per cent. ; girls, 1.09 per cent.

Mean, 1.34 per cent.

Something between 1 per cent. and 2 per cent. is probably true for England ; Dr. James Kerr thinks the final estimate will be nearer the latter value.<sup>1</sup> We therefore conclude that the 332 mentally defective children in Stockholm, giving 1.23 per cent., are very close to the English numbers, and that in taking practically the whole of the Stockholm children in the 'help-classes' we have reached a fair sample of the population usually classed in this country also as mentally defective. Just as in England, so the teacher in Sweden is the principal factor in the selection, and in both countries there are fewer recognized mental defectives of the ages 7 and 8, because those ages are young for accurate discrimination.

Of the .04 per cent. of children (12 cases in all) of a low mental grade at the special centres we have no records by Binet-Simon tests. But in the 301 children in the 'help-classes', we have the bulk of the child mental defectives corresponding to the 1 to 2 per cent. of the English cases.

With regard to the control series of normal children, the matter was rather more difficult, because a selection had in some way to be made out of the 25,000 'normal' children, and the relative amount of time that the application of the tests takes was against the possibility of dealing with very large numbers. It is probable that some system of purely random selection could have been devised to give an adequate result, but actually other considerations came in ; the small sample of children were to be scattered through all ages at school and through the various classes. Preliminary investigations had shown that there was no marked difference between boys and girls when intelligence was determined by these tests. Both sexes had been measured in the small sample of the mentally defective available, so that both sexes were to be taken in the sample of normal children. Further, it was considered desirable to measure for other purposes the

<sup>1</sup> 'Extreme Alcoholism in Adults', *Galton Laboratory Memoirs*, XIV. Dulau & Co.

range of intelligence corresponding to each group of children. Accordingly, a number of classes were picked out in the case of children of seven and over, and the teachers were asked in the case of children over ten to present *twelve* children from each class for the tests. In order to obtain the extreme range of intelligence in the class, the teachers sent their four 'best', their three 'worst', and five others of 'medium' intelligence, 12 children in all being examined out of classes of 25 to 30 children.<sup>1</sup> Thus 40 to 50 per cent. of the children only in the higher classes were examined. The effect of this selection, we might anticipate, would be to increase the variability in intelligence of the normal children. As a matter of fact, the variability of the unselected mentally defective children shows an increase of 50 per cent. on the variability of the selected normal children.

It is, therefore, extremely probable that the more accurate psychological measurement of intelligence involved in Binet-Simon tests was not very closely correlated with the teachers' rough general appreciation of the children's intelligence. A very little study shows that the 261 sample of 'normal' children rather lacks variability than shows excess of it. Probably this can be accounted for by the selection of boys and girls for 'Vorgymnasia' and private schools, but this source of selection will certainly not leave much, if any, balance to account for an increase of variability following on a teachers' selection. Actually, if 1,500 children are selected for high-grade schools, while 25,499 are left in the public elementary schools, we should expect 15 such children to correspond to an elementary school population of 261 children. Or, to make our sample complete, we ought to take 276 children. But as no observations were made on the intelligence of the children transferred to the higher-grade schools, it is not possible to add directly to the 261 children an additional 15 with an appropriate distribution of intelligence. But we can obtain some appreciation, as we shall see later, of what influence this selection has had.

We have already seen that the *apparent* percentage of mentally defective children in Stockholm is 1.23, but this is very far from being a real measure of the prevalence of mental defect, because (i) the weakness of intellect cannot be definitely ascertained much before 9 years of age, (ii) a backward child may be taken to be mentally defective, but the sympathetic treatment in the 'help-classes' or improved nutrition may, as it grows older, cause it to develop more effective intelligence, and (iii) the normal children begin at the age

<sup>1</sup> For the exact nature of the selection see Appendix, p. 42.

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12 to pass out of the elementary school population, but the mentally defective are kept much longer at school. For these reasons we should anticipate that the percentage of mentally defective children would rise steadily from 7 to 10 years, would then fall somewhat from 10 to 12, this fall measuring any curative effect of the 'help-classes', and finally rise rapidly, as the school population of normals from 13 to 14 dwindles far more quickly than the school population of mental defectives. The accompanying table shows markedly these influences :

PERCENTAGE OF MENTALLY DEFECTIVE SCHOOL-CHILDREN AT EACH AGE IN THE ELEMENTARY SCHOOLS OF STOCKHOLM.

Age.	Normals.	Mental Defectives		Percentage of
		in 301	in 332	Mental Defectives.
Below 7	9	?	?	?
7-8	3481	3	3.31	0.10
8-9	3661	21	23.16	0.63
9-10	3800	33	36.40	0.95
10-11	3794 <sup>1</sup>	58	63.97	1.66
11-12	3803	53	58.46	1.51
12-13	3491	47	51.84	1.46
13-14	3391	59	65.08	1.88
14-15	1374	27	29.78	2.12
Over.	112	?	?	?

Judged from this table it would seem that the most reasonable estimate of the prevalence of mental defect is to be formed when all the mentally defectives have been definitely selected and the normal children have not yet begun to leave school, i. e. at the ages 11 and 12. For Stockholm, this leads up to a mentally defective percentage of about 1.5. It would be of interest to consider similar data for England.

### (II) NATURE OF THE BINET-SIMON PROCESS.

It will be remembered that the Binet-Simon process gives for each age a series of test problems which will be solved in a certain large percentage of cases by children of normal intelligence of the given age. The Binet-Simon solution frequency is 75 per cent. In the present investigation the tests used were not in all cases those which belonged to the Binet-Simon original method; the joint-author who dealt with the psychological investigation worked out most of the tests used himself,

<sup>1</sup> From this point onwards the 300 children transferred to the higher-grade schools are added.

founding them on the Binet-Simon method, but adopting in some cases a solution frequency of 55 per cent. Further, there were some divergences between the tests applied to the normal and to the mentally defective groups.<sup>1</sup> It was noted that the mentally defective children showed a greater 'behindness' in tests of intelligence proper (combination-tests, tests for thinking with the aid of language) than in tests of general intelligence. All these points will be considered with more detail in a psychological paper published elsewhere. For our present purposes it suffices to remind the reader that by the Binet-Simon process a child may be able to answer the tests that correspond to its own age, or to an age above its own age, or only to an age below its actual age.<sup>2</sup> In this way each child is provided with a 'mental age', and the difference between its actual physical age and its mental age is a measure, as the case may be, of its mental excess or its mental defect. In a population of normal children the average mental age of each age-group should be equal to the physical age within the limits of probable error, and there should thus be no correlation between the physical age and the grade of intelligence as measured by the difference of the mental and physical ages.

But a point arises here; it is a long and difficult process to accurately adjust the tests so that for normal children this correlation shall be zero. It will probably, in almost every case, turn out to have a small, but significant, positive or negative value. This will hold true, if tests devised for a child population of one race be applied to a second, for rate of intellectual development with age varies from race to race. Further, a process by which, as the children grow older, the more able or the more feeble are thrown out from the population measured, may also influence the nature of the correlation between physical age and grade of intelligence. But the theory of correlation enables us to correct for any actual correlation between physical age and grade of intelligence, and to deduce *a posteriori*, if not *a priori*, a series of *corrected* tests for which in any population, normal or otherwise, the average mental age agrees with the physical age. We can then use these tests after correction to compare any special population against the first population. For most cases, the determination of the 'regression line' in the first population will amply suffice to supply the requisite corrections. The corrected mental ages will then form an adequate and proper

<sup>1</sup> This point and others are discussed more fully in the Appendix describing the nature of the tests used. See our pp. 39-43.

<sup>2</sup> See for rather more full detail the Appendix.

measure of the mental excess or defect, as the case may be, of an individual child or any selection of special children. We are thus in a position to measure simply in years the actual ‘mental defect’ at each age of the feeble-minded child, noticing its deficiency from the proper mental equipment of the normal child of the same physical age.

It is not of course possible to assert *a priori* that ‘intelligence years’ at every point of the scale, or in excess and defect at each special age, are of equal value. But while growth in general is certainly during childhood logarithmic in character—when measured, say, from 3 to 19 years—a portion of such a curve between 7 and 14 years, i.e. the school period under consideration, can for physical characters certainly be

TABLE A. EXCESS IN INTELLIGENCE YEARS

	+ 2.05	+ 1.75	+ 1.45	+ 1.15	+ 0.85	+ 0.55	+ 0.25	— 0.05
	—	—	—	—	—	—	—	—
	+ 1.75	+ 1.45	+ 1.15	+ 0.85	+ 0.55	+ 0.25	— 0.05	— 0.35
Ages under 9 . .	1	2	7	4	9	11	20	11
Ages 10 to 12 . .	0	2	1	1	8	10	9	8
Ages under 9 . .	2.9	5.8	20.3	11.6	26.2	32.0	53.1	32.0
Ages 10 to 12 . .	0	6.3	3.1	3.1	25.2	31.5	28.3	25.2
Δ	+ 2.9	— 0.5	+ 17.2	+ 8.5	+ 1.0	+ 0.5	+ 29.8	+ 6.8
( ————— + 66.2 = + 15 + 51.2 ————— )								

adequately represented by a straight line. In other words, in physical characters a year at each age between 7 and 14 years marks equal average growth-increments.<sup>1</sup> It is, therefore, *a priori* reasonable to assume—knowing how closely mental characters follow the growth-laws of physical characters—that ‘intelligence years’ are equal in the same close manner that ‘stature years’ or ‘auricular-height years’ between 7 and 14 are equal. As we shall see, the ‘intelligence year’ is very nearly the standard deviation of mental variability in normal children, and so very closely equal to the 100 ‘mentaces’ of Pearson’s intelligence scale.<sup>2</sup>

<sup>1</sup> Compare, for example, the graph for the growth of auricular height in girls’ heads from 3 to 19 in *Biometrika*, vol. iii, p. 141, and note how the observations between 7 and 14 are more closely linear than even the corresponding portion of the fitted curve.  
<sup>2</sup> *Biometrika*, vol. v, p. 109.

(III) CORRECTION OF THE RAW DATA.

We have already noted that the population of elementary school children is subject to two forms of selection, (i) the concentrated selection from the ninth to the tenth year of the abler boys and girls, particularly of the abler boys, who pass into higher-grade schools, and (ii) the more or less continuous selection from 7 years on to 9 or 10 of the mentally defective children, who pass into the ‘help-classes.’ Of these two selections, the latter is in a sense the less important, for it only amounts to 1·2 per cent.; and accordingly, from our 261 children, we might anticipate that some 3 mentally defectives had been thus removed. On the other hand, some 15 children of more than average ability have most probably been selected for transfer to ‘Vorgymnasia’ and

NORMAL POPULATION.

—0·35	—0·65	—0·95	—1·25	—1·55	—1·85	—2·15	—2·45	—2·75	Totals.
—0·65	—0·95	—1·25	—1·55	—1·85	—2·15	—2·45	—2·75	—3·05	
7	5	7	2	5	1	2	1	0	95
12	9	11	3	3	4	0	1	1	83
20·4	14·5	20·3	5·8	14·5	2·9	5·8	2·9	0	276
37·8	28·3	34·6	9·4	9·4	12·6	0	3·1	3·1	261
—17·4	—13·8	—14·3	—3·6	+5·1	—9·7	+5·8	—0·2	—3·1	15
(————— —51·2 —————)									

other higher-grade schools. In the absence of the mentally defective, we should have 276 ‘normal’ children, where we actually have 261 representatives. Now let us endeavour to consider this point at a little greater length. Let us suppose there to be no correlation between intelligence grade and age in normal children. Then if we took the distribution of 276 children under 9 from the public elementary schools, and then again of 261 children over 10 and under 12, when the abler children apparently begin to leave school, the difference should show the ability-distribution of the 15 children drafted to the higher-grade schools. We have, out of the 261 normal children actually tested, 95 children under 9 years, and 83 between 10 and 12 years; the distributions are given in the above table (Table A) and are then modified to represent 276 and 261 children

respectively. The difference between these two distributions is given in the row below the table marked  $\Delta$ .

Now the mean intelligence of the whole normal population observed is  $-0.16$  intelligence years, and if we divide beyond the group ( $-0.5$  to  $-0.35$ ) in which this mean occurs, we see that the younger children have excess of mental capacity in all but one group above this division, and defect of each grade of mental capacity in all but two groups below this. The excess in the higher grades amounts to 66.2 children and the defect in the lower grades to 51.2 children. Thus not only have 15 children been selected from groups over the mean, but 51 children also have been transferred from a high grade to a low grade of mental capacity. Now some very interesting points flow from this: (i) The children selected for 'Vorgymnasium' standard cannot have been of a remarkable mental excess; the bulk of them can hardly have shown more than a year to a year and a half mental excess. They in no wise appear as a long tail of extreme mental excess—we are clearly not dealing with a selection of marked ability. (ii) There is no sign of a reduction in the mentally low grades of the older children owing to the removal of feeble-minded children, but on the contrary (iii) a large number of children must, with increasing age, have been transferred from higher to lower grades of mental capacity. The discussion of the effect of transferring 15 children from the more able children and 3 children from the mental defectives to other schools or classes seems accordingly idle until the correction for the correlation of age and intelligence grade has been made, because this factor screens all the effect of selection. Unfortunately, having no measure of the ability of the children removed, we cannot include them before calculating the corrections. We are therefore reduced to calculating the corrections without regard to the selection, and then investigating in broad categories how the difference between the children before and after selection stands. The data are very irregular, owing to the smallness of the numbers, and can only be smoothed out in broad categories. The following have been adopted: (a) capable children, i. e. with over 1 year of mental excess, (b) dull children with over  $1\frac{1}{2}$  years of mental defect, (c) mediocre children, with a range from  $1\frac{1}{2}$  years of mental defect to 1 year of mental excess. The following results were obtained from the corrected data in Table III, p. 26:

TABLE B. EFFECT OF SELECTION, CORRECTED DATA IN BROAD CATEGORIES.

Ages.	Total.	Capable Children.	Mediocre Children.	Dull Children.
Under 9	95	11	75	9
10 to 12	83	5	72	6
Under 9	279	32·3	220·3	26·4
10 to 12	261	15·7	226·4	18·9
Δ	18	+ 16·6	− 6·1	+ 7·5
Selection	18	+ 15	0	+ 3

The table shows that after correction, the older children now show a deficit of between 16 and 17 of the more capable children and a deficit of between 7 and 8 of the dull children. Although the final numbers are not very satisfactory, they show the terminal selections at least in the sense we should anticipate. This investigation serves to confirm the view that the capable children removed to higher-grade schools are not a ‘tail’ of marked ability, but are practically concentrated in the group of 1 to 1½ years mental excess, and not in groups of higher ability.

Bearing these points as to the nature of the selection in mind, we now turn to the actual reduction of the data.

Table I gives the correlation between the physical age and the ‘mental excess’, i.e. mental age minus physical age as measured by Binet-Simon tests for 261 normal Swedish children. Table II gives the same correlation for 301 mental defectives. The following Table C provides the constants for these tables, the units being years and decimals of a year.

Now quite a number of most interesting points flow at once from this table (p. 16).

(i) We see that the physical age of the normal children is on the average a year and nine months less than that of the mentally defective children. This is partly due to the mentally defective children remaining longer at their schools, and partly to the fact that until there has been some reasonable school experience a child is not transferred to a ‘help-class’. In England, the selection of the mentally defective children for special schools does not take place until they are at least 7 or 8 years of age.

TABLE I. PHYSICAL AGE AND MENTAL DEFECT. NORMAL MENTAL

Physical Age.	+ 2.05 — + 1.75	+ 1.75 — + 1.45	+ 1.45 — + 1.15	+ 1.15 — + 0.85	+ 0.85 — + 0.55	+ 0.55 — + 0.25	+ 0.25 — − 0.05	− 0.05 — − 0.35
6.45-6.95	—	—	1	—	—	2	3	1
6.95-7.45	—	—	3	1	1	3	8	1
7.45-7.95	1	—	—	1	1	2	6	3
7.95-8.45	—	1	2	1	2	3	2	5
8.45-8.95	—	1	1	1	5	1	1	1
8.95-9.45	1	—	3	2	1	6	4	2
9.45-9.95	—	1	—	3	—	4	5	—
9.95-10.45	—	1	1	—	2	6	2	—
10.45-10.95	—	—	—	1	3	2	2	4
10.95-11.45	—	—	—	—	1	—	1	2
11.45-11.95	—	1	—	—	2	2	4	2
11.95-12.45	—	2	4	3	1	3	1	—
12.45-12.95	—	—	—	2	—	2	2	1
12.95-13.45	—	—	—	—	—	—	1	—
13.45-13.95	—	—	—	—	—	—	—	—
Totals	2	7	15	15	19	36	42	22

TABLE II. PHYSICAL AGE AND MENTAL DEFECT. MENTALLY MENTAL

Physical Age.	− 0.0 — − 0.45	− 0.45 — − 0.95	− 0.95 — − 1.45	− 1.45 — − 1.95	− 1.95 — − 2.45	− 2.45 — − 2.95	− 2.95 — − 3.45	− 3.45 — − 3.95
7.45-7.95	—	—	1	—	1	—	—	1
7.95-8.45	—	—	—	1	2	1	—	2
8.45-8.95	—	—	1	5	6	3	—	—
8.95-9.45	—	1	2	4	4	4	1	—
9.45-9.95	1	3	2	2	3	2	2	—
9.95-10.45	—	2	8	2	5	4	2	5
10.45-10.95	—	1	5	3	7	3	5	2
10.95-11.45	—	—	1	1	4	6	7	2
11.45-11.95	1	1	2	5	6	5	6	2
11.95-12.45	—	—	—	3	2	3	7	5
12.45-12.95	—	—	—	1	2	—	2	3
12.95-13.45	—	—	3	3	3	3	6	8
13.45-13.95	—	—	—	—	—	3	2	6
13.95-14.45	—	—	—	—	2	—	3	2
14.45-14.95	—	—	—	—	—	1	—	1
Totals	2	8	25	30	47	38	43	39

LDREN. UNCORRECTED DATA.  
ESS.

0.35 — 0.65	—0.65 — —0.95	—0.95 — —1.25	—1.25 — —1.55	—1.55 — —1.85	—1.85 — —2.15	—2.15 — —2.45	—2.45 — —2.75	—2.75 — —3.05	Totals.
—	—	—	—	—	—	—	—	—	7
—	—	—	—	1	—	—	—	—	18
2	—	2	—	3	—	—	—	—	21
3	2	2	1	1	—	1	—	—	26
2	3	3	1	—	1	1	1	—	23
1	1	—	—	1	—	—	—	1	23
2	1	1	1	—	—	—	—	—	18
1	2	4	—	—	2	—	—	—	21
4	2	2	3	1	—	—	—	—	24
4	1	3	—	2	1	—	—	1	16
3	4	2	—	—	1	—	1	—	22
1	2	1	—	1	—	—	—	—	19
2	3	1	—	—	1	1	—	1	16
—	—	—	1	—	2	—	—	—	4
1	1	—	—	—	—	1	—	—	3
26	22	21	7	10	8	4	2	3	261

ECTIVE CHILDREN. UNCORRECTED DATA.  
ESS.

—3.95 — —4.45	—4.45 — —4.95	—4.95 — —5.45	—5.45 — —5.95	—5.95 — —6.45	—6.45 — —6.95	—6.95 — —7.45	—7.45 — —7.95	Totals.
—	—	—	—	—	—	—	—	3
—	—	—	—	—	—	—	—	6
—	—	—	—	—	—	—	—	15
—	1	—	—	—	—	—	—	17
—	1	—	—	—	—	—	—	16
—	2	—	—	—	—	—	—	30
1	1	—	—	—	—	—	—	28
1	—	—	—	—	—	—	—	22
1	1	—	1	—	—	—	—	31
2	3	2	—	—	1	—	—	28
1	5	3	2	—	—	—	—	19
7	1	1	—	—	—	—	—	35
6	—	3	1	1	2	—	—	24
3	5	2	—	1	1	—	—	19
1	—	2	1	—	1	—	1	8
23	20	13	5	2	5	0	1	301

(ii) Notwithstanding that the mentally defective children are physically 21 months older, we see that mentally they are about 14 months younger than the normal children.

(iii) The 'mental excess' is in both cases a *defect*, but it only amounts to about 2 months in the case of the normal children; in the case of the mentally defective children it is on the average three years.

(iv) The correlation between mental excess and physical age is for normal children sensible but small; for mentally defective children it is quite substantial. The regression coefficient of mental defect on physical age is four times as great for the mentally defective as for the normal children.

TABLE C. UNCORRECTED DATA CONSTANTS.

Constant.	Normal Children.			Mentally Defective Children.		
	Physical Age $a_p$	Mental Age $a_m$	Mental Excess $e$	Physical Age $a_p$	Mental Age $a_m$	Mental Excess $e$
Mean Standard Deviation }	$9.863 \pm .075$	$9.704 \pm .079$	$-.163 \pm .041$	$11.595 \pm .068$	$8.554 \pm .059$	$-3.041 \pm .052$
	$1.802 \pm .053$	$1.890 \pm .056$	$.985 \pm .029$	$1.738 \pm .048$	$1.509 \pm .041$	$1.338 \pm .037$
Correlation }	$-.1743 \pm .0405$			$-.5471 \pm .0272$		
$r_e a_p$ }	$-.0953$			$-.4212$		
Regression co- efft. $e$ on $a_p$ }	$e = .7769 - .0953 a_p$			$e = .5619 - .4212 a_p$		
Eqn. to re- gression line }						

(v) We see that these tests do not exactly satisfy the hypothesis of average equality of mental and physical ages in normal Swedish children. Normal Swedish children fall somewhat behind their physical ages, namely, about one month for every additional year of physical age. This is the extent of failure of these Binet-Simon tests as applied to normal Swedish children. Remembering that  $e = a_m - a_p$ , we find—

Probable  $a_m$  for any array of physical ages

$$= a_p - (.0953 a_p - .7769).$$

Hence we must add to each mental age the quantity  $.0953 a_p - .7769$  in order to bring these tests into line for Swedish normal children. The result of this correction will be considered in the next section.

We notice, however, that without this correction these Binet-Simon tests are approximately true, i.e. the mental and physical ages do not differ widely, the variabilities of both are nearly equal and the correlation between mental excess and physical age is fairly small.

(vi) None of these conclusions can be drawn for the mentally defective children. For every year of life their mental age falls on an average 5 months more behind their physical age. They are thus aptly described by the German term 'geistig Zurückgebliebene'. They fall mentally more and more behind. Their variability in mental age is less than the variability of normal children (1.5 as compared with 1.9). On the average they do not cease to make progress, but it is only at a little more than half the rate of normal children.

We will now consider the frequency distributions of mental excess for the normal and mentally defective children as shown in Table D. We must bear in mind of course that the two groups of children have not the same age distributions.

Now we see at once from this distribution that 193 of the feeble-minded children, or 64 per cent., when tested for intelligence, have grades of mental defect which are presented by cases of normal children. It is perfectly true that no single mentally defective child has a mental age equal to its physical age, but 142 normal children have mental ages less than their physical ages, or 54 per cent. of such children.

Judged by all the caution and care of a fairly adequate, although far from perfect psychological test, there is no distinction between some one or other of 54 per cent. of normal children and some one or other of 64 per cent. of mentally defective children. While the psychologist, after careful testing of a child with one to three years of mental backwardness, would be unable to determine whether such a child was a negative variation from the normal group of children or a positive variation from the feeble-minded, the field-worker with no special training in psychology is prepared to tell us that this child is a Mendelian recessive and lacks a determiner of normal mentality, or is a Mendelian dominant and possesses this mentality! In truth there is no such intellectual boundary between the normal and mentally defective. The distribution of intelligence in both normal and mentally defective is *absolutely continuous*, and in purely psychological tests of intelligence there are no rigid and limited categories of normal intelligence and feeble-mindedness. There is a continuous graduation of intelligence, and it appears to us perfectly idle to speak

of Mendelian units and lack of determiners in respect of such a character. There is no greater danger to science, no greater evil to social progress, than obsession to a theory. A child with two years' defect in its mental development will be classed as normal or mentally defective according to the personal equation of the observer, and with 54 per cent. of one category ranging over 64 per cent. of a second, any desired ratios can be extracted from the facts even without conscious bias.

The reader may rest assured that until the mental age of a child is something like four years in arrear of its physical age it is not possible to dogmatically assert, on the basis of the most scientific test yet pro-

TABLE D.    UNCORRECTED FREQUENCIES

Class.	+ 2.05	+ 1.55	+ 1.05	+ 0.55	+ 0.05	- 0.45	- 0.95	- 1.45	- 1.95	- 2.45
	—	—	—	—	—	—	—	—	—	—
	+ 1.55	+ 1.05	+ 0.55	+ 0.05	- 0.45	- 0.95	- 1.45	- 1.95	- 2.45	- 2.95
Normals .	6	24	28	61	49	38	26	16	8	4
Defectives	—	—	—	—	2	8	25	30	47	38

posed as a measure of intelligence, that it is feeble-minded. Even then all we can say is that such a child would be unlikely to occur once in 261 normal children, or occurs under  $\frac{1}{2}$  per cent. in the normal child population.

How then has it come about that such 'mentally defective' children have been drafted off into special classes or schools and classed under a separate category? Clearly not by their intelligence, but by the combined personal equations of teachers, school nurses, and medical officers, judging and determining by a whole variety of factors, which make for practical social efficiency—such as capacity and willingness to learn, power of self-control, habits of cleanliness, moral order, power or desire of attention to instruction, fits, possibly epilepsy, and a vast variety of semi-physical deficiencies.<sup>1</sup> The term feeble-mindedness is a misnomer; these children would be better termed 'social inefficients'; they have, on the whole, a lower grade of mental power, and are more mentally deficient than some normal children, but there is no sharp division between them and normal children in the matter of mentality. Because they are socially inefficient, a wise social system would segregate them and make special provision for their protection and sustenance. But it appears idle to attempt the differen-

<sup>1</sup> See Appendix, Note II.

tiation of them from the normal community by the assertion that their soma lacks the ‘unit character’ upon which normal mental development depends! Any such pseudo-scientific dogma which supports an absolute differentiation between the normal and the mentally-defective child is bound to do incalculable social harm. At present whether a child is to be considered normal or mentally defective is largely a matter of personal equation in teacher or medical officer. To assume any rigid division is bound sooner or later to lead to the gravest difficulties. As far as mental state is concerned, all we can wisely do is to take some test like the Binet-

DISTRIBUTIONS OF MENTAL EXCESS.

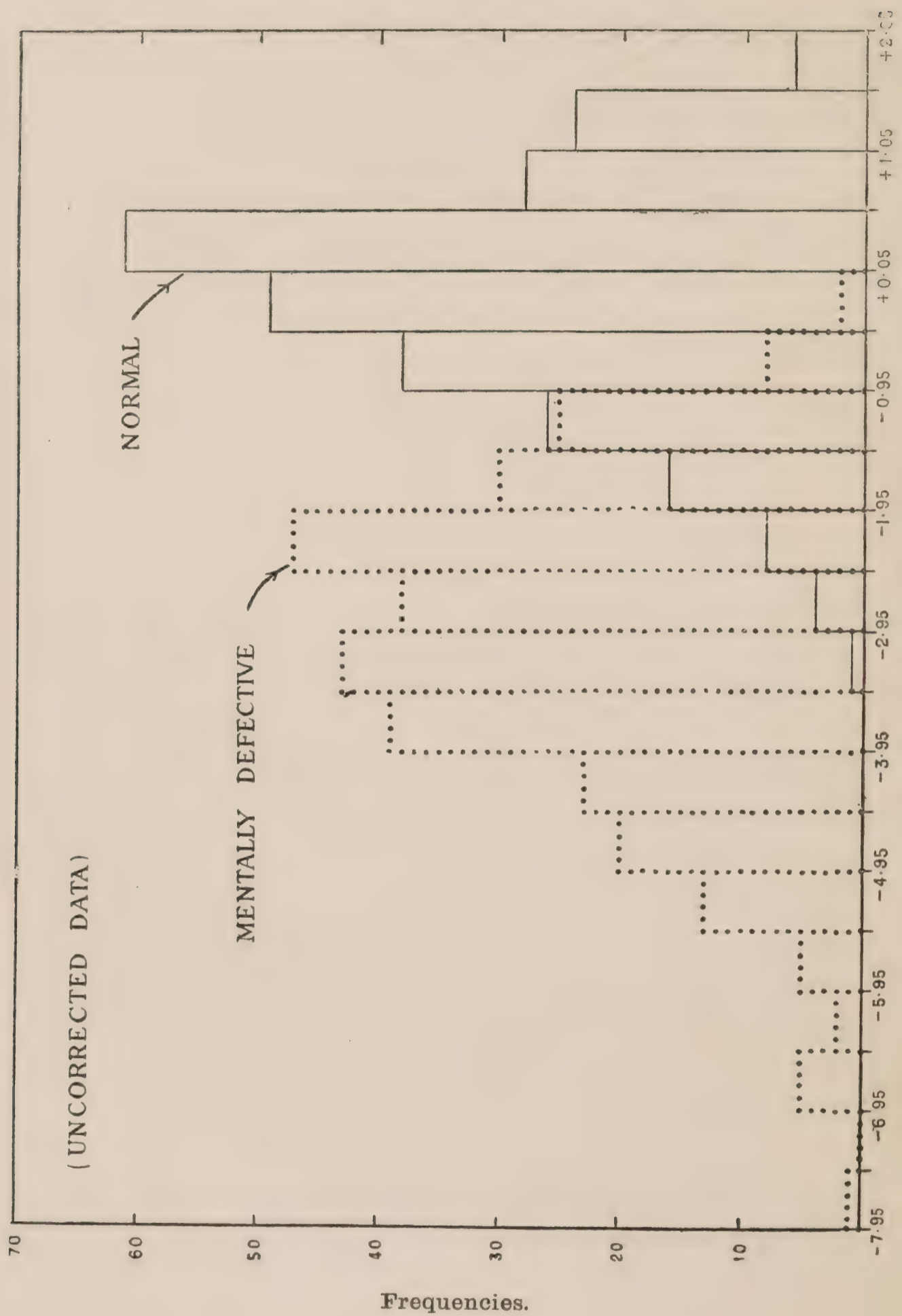
2.95	—3.45	—3.95	—4.45	—4.95	—5.45	—5.95	—6.45	—6.95	—7.45	Totals.
—3.45	—3.95	—4.45	—4.95	—5.45	—5.95	—6.45	—6.95	—7.45	—7.95	
1	—	—	—	—	—	—	—	—	—	261
43	39	23	20	13	5	2	5	0	1	301

Simon—when it has been finally established or modified by wider experience—and say, when a child lacks mentally four, five, or whatever limit of years be chosen of its physical age, then this child shall have special provision made for it. This is all we can do for the mentally deficient; for the socially inefficient a mental test cannot cover the ground; moral and physical considerations must come in. But why should we prejudice *ab initio* the whole study of the group of social inefficients now classed as mental defectives, by manufacturing hypotheses of Mendelian units, of determiners of mental development, of the recessive character of feeble-mindedness *et hoc genus*, before any full and proper analysis or investigation of mental defect has been carried out?

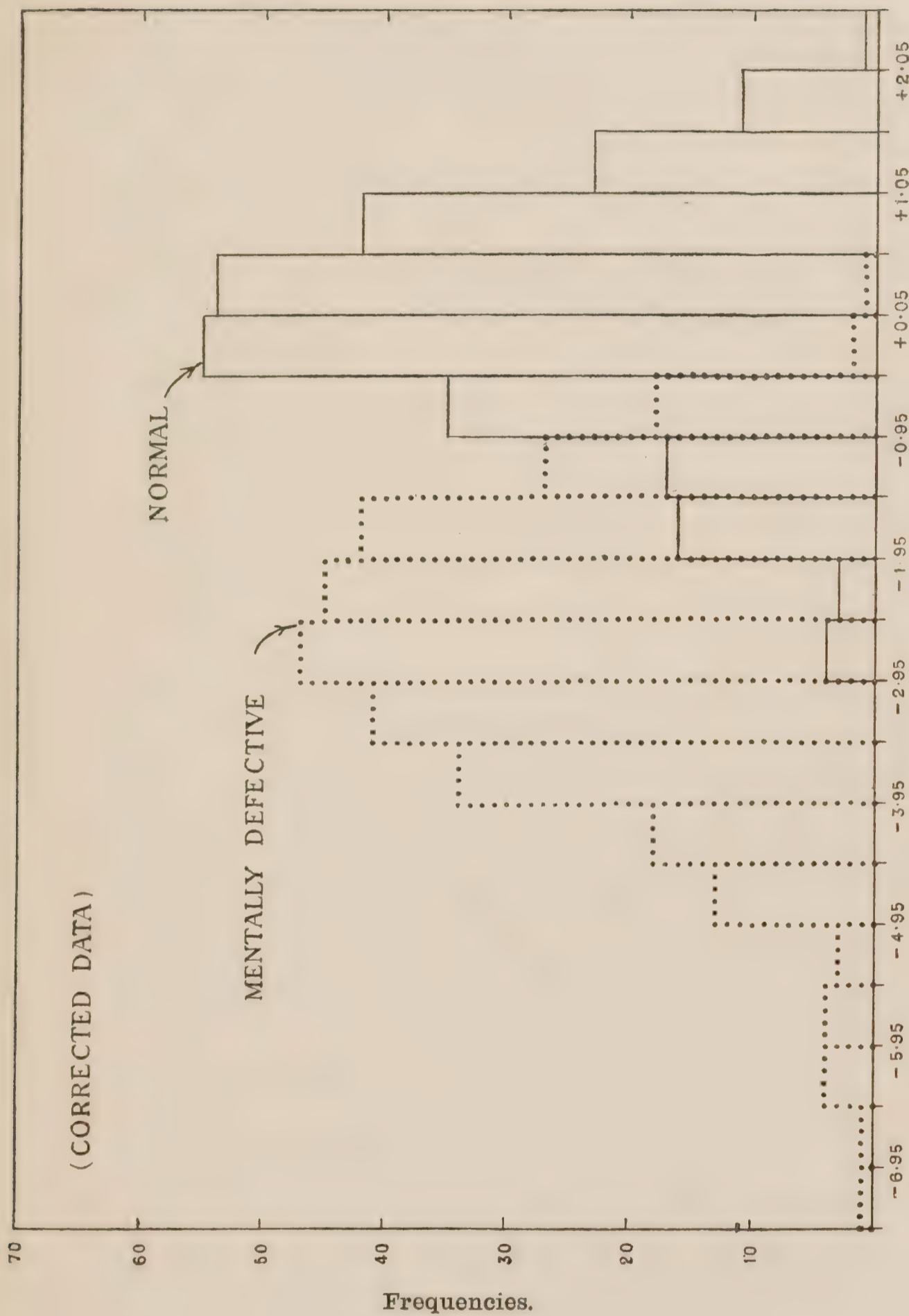
Diagram I will bring graphically before the reader the wide extent to which normal mentality and feeble-mindedness cover the same range. Diagram II indicates how ‘mental defect’ increases for both populations with increasing age.

(IV) DISCUSSION OF THE CORRECTED DATA.

Tables III and IV p. 26) give the correlation of physical age and the ‘mental excess’ for normal and mentally defective children respectively, when by aid of the regression line of the uncorrected normal data, the



Grade of Mental Defect.  
DIAGRAM I.



Grade of Mental Defect.

DIAGRAM II.

22      *Mendelism and the Problem of Mental Defect*

mental age of the average normal child has been made equal to its physical age as the Binet-Simon test hypothesizes. Table E provides the corrected constants, the units as before being in years and decimals of a year.

TABLE E. CORRECTED DATA CONSTANTS.

Constant.	Normal Children.			Mentally Defective Children.		
	Physical Age $a_p$	Corrected Mental Age $a_m'$	Mental Excess $e'$	Physical Age $a_p$	Corrected Mental Age $a_m'$	Mental Excess $e'$
Mean Standard Deviation }	$9.863 \pm .075$	$9.868 \pm .086$	$+ .006 \pm .040$	$11.595 \pm .068$	$8.888 \pm .066$	$- 2.702 \pm .049$
	$1.802 \pm .053$	$2.063 \pm .061$	$.960 \pm .028$	$1.738 \pm .048$	$1.693 \pm .047$	$1.260 \pm .035$
Correlation } $r_{e'a_p}$ }	$.0105 \pm .0417$			$- .4566 \pm .0308$		
Regression co- } eff. $e'$ on $a_p$ }	$.0006$			$.3310$		
Equation to } regression line }	. . . . .			$e' = 1.136 - .3310 a_p$		

It will be seen that for normal children the mental excess is now only + .006, and insignificant as compared with its probable error. The correlation of mental excess and physical age is now only .01 with a probable error of 04 . Thus the Binet-Simon hypothesis is fulfilled by the corrected data. On the other hand, the average mentally defective child is still 2 years and 8 months mentally behind its physical age, and the correlation between mental defect and physical age has still the substantial value  $.46 \pm .03$ , i.e. the relation between the two is as intimate as that between parent and child. It will be seen that for every additional year of age the mentally defective child on the average falls another four months behind its physical age. An examination of

TABLE F. CORRECTED FREQUENC

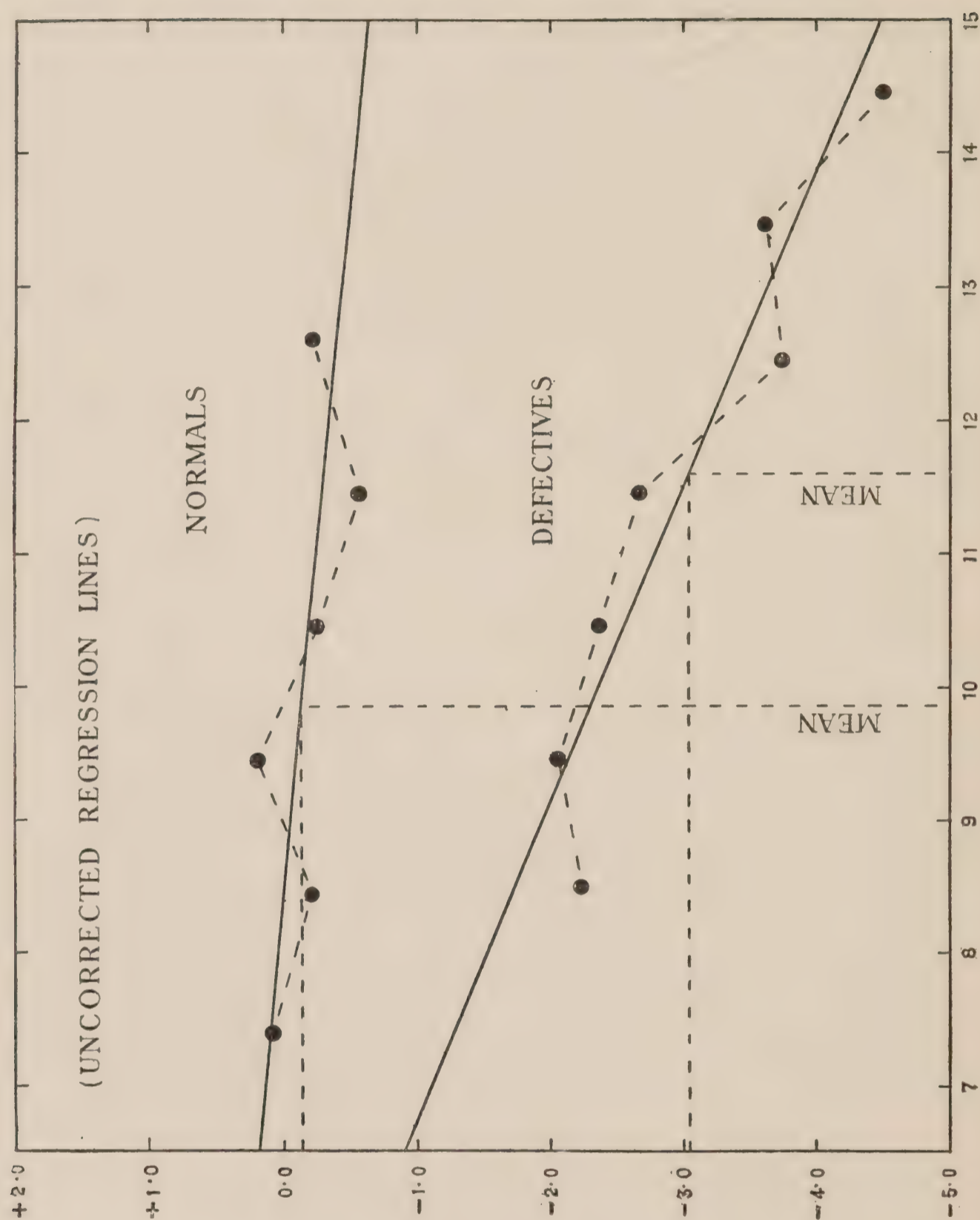
	$+ 2.55$	$+ 2.05$	$+ 1.55$	$+ 1.05$	$+ 0.55$	$+ 0.05$	$- 0.45$	$- 0.95$	$- 1.45$	$- 1.95$
	$+ 2.05$	$+ 1.55$	$+ 1.05$	$+ 0.55$	$+ 0.05$	$- 0.45$	$- 0.95$	$- 1.45$	$- 1.95$	$- 2.45$
Normal Children .	1	11	23	42	54	55	35	17	16	3
Mentally Defective	-	-	-	-	1	2	18	27	42	45

Table IV does not seem to indicate that the older mentally defective children break up into two differentiated classes, i.e. those who make no progress at all and those who progress only at a much slower rate than normal children. On the other hand, to judge from the regression as plotted in Diagram III, there is not much increase of mental defect from 8 to 12; it is roughly 2 years. Then at about 12 there is a rapid increase. Our data are not sufficiently numerous to lay any great stress on this change, but with more ample data, the point whether with oncoming puberty there is more mental stagnation in the mentally defective is deserving of fuller consideration than is here possible on our limited material.

We may now compare the frequencies of normal and mentally defective children in the same manner as we did for the uncorrected data in Table D. Thus 70·5 per cent. of normal children fall into the range of intelligence of the so-called mentally defective; and 60·5 per cent. of so-called mentally defective children have an intelligence comparable with that of some normal children. There cannot accordingly be any chance of our being able definitely to differentiate 60·5 per cent. of so-called mentally defective children from normal children by the aid of a purely intelligence test like the Binet-Simon. It would thus appear that the selection which has sent these children to special classes for the mentally defective is based, in more than half the number of cases, on something other than ‘mental defect’ as measured by an intelligence test. Not till a mentally defective child shows at least a three years’ mental defect ought we to pretend to differentiate it merely on the ground of intelligence from so-called normal children. Thus our corrected values only emphasize what we have learnt from the uncorrected data: so-called ‘mentally defective’ children, judged by the measure of their ‘mental defect’, form a continuous distribution, and this distribution is not differentiated from that of normal children. We are dealing with a continuously graded variable, and as far as

DISTRIBUTIONS OF MENTAL EXCESS.

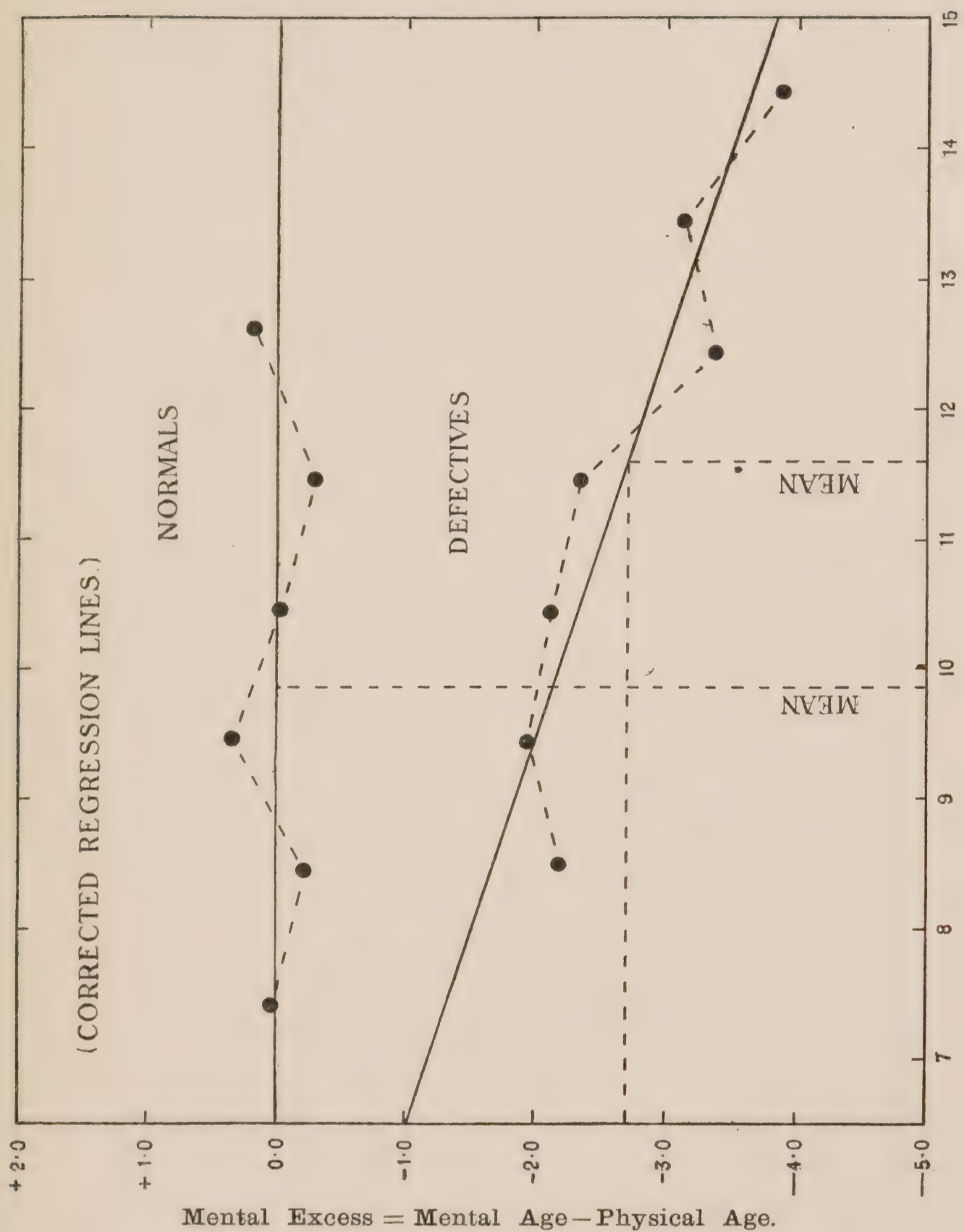
—2.45	—2.95	—3.45	—3.95	—4.45	—4.95	—5.45	—5.95	—6.45	—6.95	Totals.
—2.95	—3.45	—3.95	—4.45	—4.95	—5.45	—5.95	—6.45	—6.95	—7.45	
4	—	—	—	—	—	—	—	—	—	261
47	41	34	18	13	3	4	4	1	1	301



Mental Excess = Mental Age - Physical Age.

Physical Age (Unit = Year).

DIAGRAM III.



Physical Age (Unit = Year).

DIAGRAM IV.

TABLE III. PHYSICAL AGE AND MENTAL DEFECT. NORMAL CHILDREN. CORRECTED DATA.  
MENTAL EXCESS

Physical Age.	+ 2.55 — + 2.05	+ 2.05 — + 1.55	+ 1.55 — + 1.05	+ 1.05 — + 0.55	+ 0.55 — + 0.05	+ 0.05 — - 0.45	- 0.45 — - 0.95	- 0.95 — - 1.45	- 1.45 — - 1.95	- 1.95 — - 2.45	- 2.45 — - 2.95	Totals.
6.45-6.95	-	-	1	-	4	2	-	-	-	-	-	7
6.95-7.45	-	-	3	2	7	5	-	-	1	-	-	18
7.45-7.95	-	1	-	2	3	9	1	2	3	-	-	21
7.95-8.45	-	-	3	3	3	8	4	3	1	1	-	26
8.45-8.95	-	1	2	5	2	3	4	3	1	1	1	23
8.95-9.45	-	1	3	4	9	3	1	-	1	-	1	23
9.45-9.95	-	1	3	4	5	2	2	1	-	-	-	18
9.95-10.45	-	1	1	5	5	1	5	1	2	-	-	21
10.45-10.95	-	-	1	5	6	4	4	4	-	-	-	24
10.95-11.45	-	-	1	-	2	6	3	2	1	-	1	16
11.45-11.95	-	1	-	4	4	5	6	-	1	1	-	22
11.95-12.45	1	5	3	4	1	2	2	1	-	-	-	19
12.45-12.95	-	-	2	3	2	4	2	-	2	-	1	16
12.95-13.45	-	-	-	1	-	-	1	-	2	-	-	4
13.45-13.95	-	-	-	-	1	1	-	-	1	-	-	3
Totals	1	11	23	42	54	55	35	17	16	3	4	261

TABLE IV. PHYSICAL AGE AND MENTAL DEFECT. MENTAL DEFECTS.  
MENTAL DEFECTS

Physical Age.	+ 0.55 — + 0.05	+ 0.05 — - 0.45	- 0.45 — - 0.95	- 0.95 — - 1.45	- 1.45 — - 1.95	- 1.95 — - 2.45	- 2.45 — - 2.95	- 2.95 — - 3.45
7.45-7.95	-	-	-	1	-	1	-	-
7.95-8.45	-	-	-	-	1	2	1	-
8.45-8.95	-	-	-	1	7	5	2	-
8.95-9.45	-	-	1	2	6	2	4	1
9.45-9.95	-	1	3	3	3	2	2	1
9.95-10.45	-	-	7	4	3	7	1	3
10.45-10.95	-	-	2	5	5	5	6	2
10.95-11.45	-	-	1	1	3	5	7	3
11.45-11.95	1	1	1	4	6	3	9	1
11.95-12.45	-	-	-	1	3	4	5	6
12.45-12.95	-	-	-	1	1	1	-	5
12.95-13.45	-	-	3	3	3	3	6	8
13.45-13.95	-	-	-	-	-	3	2	6
13.95-14.45	-	-	-	1	1	1	2	4
14.45-14.95	-	-	-	-	-	1	-	1
Totals	1	2	18	27	42	45	47	41

intelligence goes there is absolutely no rigid line at which we can say: Here mental defect begins ; nor is there any similar line at which we can say: Here normality ends.

It must be clear to those who will really trouble to take a quantitative measure of mental defect, that it is perfectly idle to speak of feeble-mindedness as a ‘Mendelian unit’, which is recessive to ‘normality’. With children whose mental excess is zero, down to children whose mental ‘excess’ is a defect up to at least three years, it must be largely a matter of personal equation whether they are spoken of as mentally defective or not. If they are sent—as they undoubtedly often are sent—to special classes or schools for the mentally defective, it is not wholly for their grade of intelligence ; it is because of their physical defects, their lack of self-control, feebleness of purpose, or immoral habits.<sup>1</sup> Are all these various phases of social inefficiency to be described as lack of a single Mendelian determiner, and are we to accept the gospel propounded by Bateson, on the evidence of American students of genetics, that it is ‘clear that feeble-mindedness has at least one of the marked features of a recessive condition’? The only tests we have at present of feeble-mindedness are medico-pedagogic opinion, which drafts the child into a class or school for

EFFECTIVE CHILDREN. CORRECTED DATA.  
EXCESS.

—3.45 —3.95	—3.95 —4.45	—4.45 —4.95	—4.95 —5.45	—5.45 —5.95	—5.95 —6.45	—6.45 —6.95	—6.95 —7.45	Totals.
1	—	—	—	—	—	—	—	3
2	—	—	—	—	—	—	—	6
—	—	—	—	—	—	—	—	15
—	1	1	—	—	—	—	—	17
3	2	—	—	—	—	—	—	16
2	1	—	—	—	—	—	—	30
2	—	—	—	—	—	—	—	28
3	1	—	—	1	—	—	—	22
3	3	2	—	—	—	1	—	31
1	5	3	1	1	—	—	—	28
7	1	1	—	—	—	—	—	19
6	—	3	1	1	2	—	—	35
3	4	1	—	1	1	—	—	24
1	—	2	1	—	1	—	1	19
								8
34	18	13	3	4	4	1	1	301

<sup>1</sup> See Appendix, Note II.

the mentally deficient, or on the other hand, the Binet-Simon test for intelligence. There is no evidence that the American students of genetics applied the latter to determine whether a child was to be termed mentally defective or not, but if they had done so, all they could assert would be that *they* called feeble-minded all that had a certain grade of mental defect. Such a grade is not a biological entity, but purely a matter of personal equation, and it is absurd to speak of what occurs on one side of this line as corresponding to a Mendelian 'recessive', and what occurs on the other side of it as a Mendelian 'dominant'. If, on the other hand, they accepted in their classification of 'feeble-mindedness' the medico-pedagogic selection for instruction in a special school for the mentally deficient, then it will be clear from the above investigation that their 'feeble-mindedness' covers many persons who can be considered of quite normal intelligence, and who, although lacking in other characters necessary for social efficiency, do not necessarily lack intelligence. What scientific knowledge concerning the heredity of mental defect can possibly arise by including in one category, as a 'lack of a single determiner' or as 'a Mendelian recessive', a wide range of characters, which have clearly no part whatever in true mental defect? Indeed, the trained psychologist would see many only partially correlated factors in such a measure of 'intelligence' as is provided by the Binet-Simon test itself! Any attempt to suppose that useful knowledge has been gained by cramming all cases of feeble-mindedness into a single Mendelian category is absurd, and can only lead in the long run to the rejection of all scientific theory by those who have from the practical side to consider the handling of the population of our special schools. The children may or may not be roughly differentiated as social inefficients; it is clear they are not absolutely differentiated by their intelligence. Mental defect is a perfectly continuous variate, and exhibits a wide series of continuous grades.

(V) ON THE PROBLEM OF WHETHER MENTAL DEFECT MAY BE CONSIDERED MERELY AS THE 'TAIL' OF THE GENERAL DISTRIBUTION OF INTELLIGENCE.

It is a very difficult matter indeed to throw any light on this problem purely from the statistical standpoint. Table F shows that mental defect is continuous and runs without rigid boundary into the range of normal intelligence.

Taking mentally defective children alone, it is clear that the dis-

tribution has considerable 'skewness'; we have a long 'tail' in the direction of extreme mental defect, a relatively short one towards mental excess. If we turn to the normals, we have to remember two points: (i) the possibility of a tail of extremely able children having been selected to proceed to higher grade schools, i.e. a clipping of the tail towards mental excess; and (ii) a certainty that, if we magnified up the distribution of normal children to its right proportions relative to the mentally defective, i.e. if we multiplied the frequency by say 120, there would be actually much longer tails to the normal distribution. That is to say, if 30,000 to 40,000 normal children had been examined, we should undoubtedly have found individuals with mental excess greater than  $+2.5$  years and mental defect greater than  $-3.0$  years. As illustration let us suppose the normal children form a Gaussian distribution, and let us ask what number of children might be anticipated to have a mental defect beyond three years, if the population of normal children were 30,000 instead of the sample of 261.

The mean (Table E) is  $+0.006$ —so that we may take the required deviation as practically 3—and the standard deviation is  $.960$ ; thus the deviation is  $3.125$  times the S.D. We find by Sheppard's Tables that the area of the 'tail' beyond the mental defect of 3 years would, for a Gaussian curve of 30,000 school children, be  $.000874 \times 30,000 =$  about 26 children. If the population had only  $\frac{1}{2}$  per cent. of mentally defective children instead of 1 per cent., i.e. were 60,000, we should have 52 children beyond the three-year mental defect limit; while if the mentally defective children were only  $\frac{1}{3}$  per cent. of the population, the normal population would have a tail of about 80. There are actually 119 mentally defective children exceeding the three-year limit. Thus if the mentally defectives in Sweden bear something of the same proportion to the normal children as in England, 50 to 70 per cent. of those whose intellectual grades are not found in a sample of 261 normal children might be found in a population of 60,000 to 90,000 normal children. In other words, assuming the distribution of intelligence in children to be approximately a Gaussian curve, there would be nothing at all unreasonable in supposing that a moiety or more of the mentally defective children with more than three years' lack of intelligence are only extreme deviations of a large population described generally as of 'normal' intelligence. There may thus be a pathological type of mental defect involving perhaps a moiety of the mentally defective children with more than 3 years' deficiency, but again we must note that it cannot be directly differentiated on the basis of intelligence

from the remainder of the tail of the mentally defective population. We should need characters other than intelligence for its discrimination.

But the problem thus stated is clearly erroneous in that we have got too low a value of the standard deviation ; we ought (see p. 11) to add 15 children of high and 3 children of low mental capacity before we calculate the standard deviation of the population. Let us put 5 extra children in the group + 1.55 to + 2.05, 10 in the group + 1.05 to + 1.55, 2 in the group - 2.95 to - 3.45, and 1 in the group - 3.45 to - 3.95 ; the mean is now + .047 and the standard deviation 1.057, and the curve for 30,000 normal children shows 70 with more than 3 years of mental defect. This still falls short of the 119, but shows how widely the tail would be extended on the side of mental defect if we had a larger population.

Let us endeavour to approach the problem from another standpoint. Hitherto we have regarded the variation of the so-called normal

TABLE G.    MOMENTS OF THE SYSTEM.    UNITS  $\frac{1}{2}$  YEAR.

	Normal Children.	Mentally Defective Children.	Combined System.
Total Frequency	$n \times 261$	301	$n \times 261 + 301$
Mean . . . .	+ .0110	- 5.4034	$\bar{x} = \frac{n \times 261 \times .0110 - 301 \times 5.4034}{n \times 261 + 301}$
Second Moment.	$n \times 261 \times 3.6853$	$301 \times 6.3519$	$\left\{ \begin{array}{l} n \times 261 \times \{ 3.6853 + (\bar{x} - .0110)^2 \} \\ + 301 \times \{ 6.3519 + (\bar{x} + 5.4034)^2 \} \end{array} \right\}$
Third Moment .	$n \times 261 \times (- 3.1047)$	$301 \times (- 9.0891)$	$\left\{ \begin{array}{l} n \times 261 \times \{ (\bar{x} - .0110)^3 + 3(\bar{x} - .0110) 3.6853 - 3.1047 \} \\ + 301 \{ (\bar{x} + 5.4034)^3 + 3(\bar{x} + 5.4034) 6.3519 - 9.0891 \} \end{array} \right\}$

children as fixing the variation of the total population, of which we have suggested the mentally defectives may be in part extreme variants ; but clearly apart from the selected tail beyond 3 years of mental defect, the selection of mentally defectives would reduce—supposing them only variants of a total ‘normal’ population—the lower grades of mental deficiency in the observed normal children, and thus reduce their standard deviation. Let us approach the problem by adding  $n$  times the frequency of the sample of normal children to that of the mentally deficient children, and determine  $n$  so as to obtain as nearly as possible a Gaussian curve for the combination. Now of course a Gaussian curve can always be found to have the same mean and standard deviation as a given distribution. We will now

suppose  $n$  so chosen as to give a higher degree of approximation to the moments—namely  $\mu_3$  for the combined frequency, i.e. the third moment coefficient, shall be taken zero. This will give us at least a higher approximation to a Gaussian distribution for the two combined groups. What sort of value does it give for  $n$ ? (See Table G.)

Actually after interpolating for  $n = 90, 70$  and  $68$ , we found for  $n = 68.5$ :

Mean =  $-.0398$  yrs. (mental defect).

Standard Deviation =  $1.0250$  yrs.

Third Moment Coefficient =  $0$ .

Such an approximation to the Gaussian would arise if the 301 mentally defectives occurred in a total of  $18,179.5^1$  children, or if the mentally defectives were  $1.66$  per cent. of the population of children. This is certainly a larger percentage than the  $.5$  to  $1.3$  per cent. we find termed 'mentally defective' in England. But, as we have seen, the Stockholm percentage of 'mentally defective' children is  $1.23$ , and many of them have as much intelligence as many normals; they are rather school inefficient than feeble-minded. Thus the hypothesis which makes the mentally defectives only extreme variations of normal intelligence leads to no obviously absurd result on the basis of a Gaussian distribution of intelligence. The method cannot possibly lead to any very exact result, because when we start with 261 children, and multiply it by  $68.5$ , we are certain to obtain a doubly curtailed frequency in the resulting  $17,878.5$  'normal' population, and the curtailment on the side of mental deficiency, as we have shown on p. 29, is likely to be quite comparable, i.e. quite of the same order, as the tail of the so-called mentally deficient population itself. Reduced to 10,000 the distribution of frequency would be that given by Table H on the following page.

It will be seen at once how markedly curtailed is the observed total distribution on the side of mental excess at  $+2.5$  years, and how equally sudden is the drop at a mental defect of  $-3$  years to the thin tail provided by the mentally defective contingent. This is one of the essential weaknesses of sampling; had we been able to take a sample of 10,000 instead of 261 normal children, these curtailments would have been far less conspicuous.

Let the reader look a little more closely into the matter. The

<sup>1</sup> A closer approximation to the actual 27,000 children would probably be reached, could we allow also for the much larger 'especially able' group cut out by the selection for higher-grade schools.

Gaussian curve has of very able children,—children with more than two years' mental excess—169·7 more than occurs in the observed children. This looks a large number, but it is actually only 1·7 per cent., or say *four* children for the 261 actually observed. That is to say, if out of that group of 15 selected children 4 children had been selected on account of special ability to beyond 2 years' mental excess to go to higher schools, there would have been enough to account for the divergence between the Gaussian and the total population on the side of excess ability. On the other hand, for children with more than three and a half years' mental defect the Gaussian only shows 4·4 children against the observed 42·8, an excess of 38·4 in 10,000, but only ·38 per cent.; so that on a population of 261, with its associated two or three mentally defective children, we should

TABLE H. DISTRIBUTION OF MENTAL EXCESS

Mental Excess.	>2·55	+2·55 — +2·05	+2·05 — +1·55	+1·55 — +1·05	+1·05 — +0·55	+0·55 — +0·05	+0·05 — −0·45	−0·45 — −0·95	−0·95 — −1·45	−1·45 — −1·90
Total Population	0	37·7	414·5	866·6	1582·6	2035·2	2073·5	1328·7	655·4	626·0
Gaussian . . .	57·6	149·8	397·1	834·0	1403·1	1809·4	1940·7	1535·6	1028·3	532·5

reach a defect of, perhaps, *one* child. Thus, while the numbers look large on the basis of 10,000 children, they do not amount to anything very significant on the numbers actually tested. If we test 'goodness of fit' on the data in Table H, we have to remember that we are actually dealing with, not 10,000 children, but 261 + their proportion, say, 3 of mentally defective children; the  $\chi^2$  comes out 906·8 for 10,000; but 23·94 for 264 children, giving a probability *P* of about ·05, or such a distribution as that found would arise about once in twenty

TABLE I. OBSERVED AND GAUSSIAN

	< +2·55	+2·55 — +2·05	+2·05 — +1·55	+1·55 — +1·05	+1·05 — +0·55	+0·55 — +0·05
Normal Children .	0	1	11	23	42	54
Gaussian Curve . .	0·65	2·49	8·39	20·99	39·02	53·92

trials, if the sample were taken from a purely normal population following the Gaussian law. This is not a very good result: see Appendix, Note III. A little over one-third of the  $\chi^2$  arises from excess of 'mental defectives', about one-sixth from defect of ability, i. e. children with mental excess over two years, and about one-sixth from the marked deficiency in the group of children with defect  $-.95$  to  $-1.45$  years. Let us now examine more fully the fit of a Gaussian curve to the population of 'normal children': in Table I below we have the observed and calculated frequencies.

Here the fit of the Gaussian distribution is by no means bad, until we reach the mentally defective side with defects of six months and over. The  $\chi^2$  for goodness of fit is  $24.54$ , giving for 13 groups  $P = .017$ ; or for such a Gaussian distribution only one such sample

TOTAL CHILD POPULATION.

1.95	-2.45	-2.95	-3.45	-3.95	-4.45	-4.95	-5.45	-5.95	-6.45	-6.95
2.45	-2.95	-3.45	-3.95	-4.45	-4.95	-5.45	-5.95	-6.45	-6.95	-7.45
37.8	176.6	22.6	18.7	9.9	7.1	1.6	2.2	2.2	0.6	0.5
18.4	70.9	18.2	3.7	0.7						

as the observed would occur in about 60 trials. But of the  $24.54$  in  $\chi^2$  no less than  $21.77$  is contributed by the irregularities on the mentally defective side of the line at 6 months' mental defect. Thus we obtain three times as probable a distribution by adding into the normal children 1.7 per cent. of mentally defective children, although when this is done we do not still obtain as satisfactory a Gaussian as we might wish for. Not demonstrated, but possible causes of this state of affairs are: (i) the curtailment by selection of a certain number of the more

FREQUENCIES OF 'NORMAL' CHILDREN.

0.05	-0.45	-0.95	-1.45	-1.95	-2.45	> -2.95
0.45	-0.95	-1.45	-1.95	-2.45	-2.95	
55	35	17	16	3	4	0
55.34	42.20	24.16	9.81	3.15	0.74	0.14

able children; the normal children contain none of any very marked ability;<sup>1</sup> (ii) the possibility of the existence of a really anomalous group of mental defectives, who, while continuously graded *inter se*, and continuously graded with the normal population as far as intelligence tests indicate, are really heterogeneous in origin, and differentiated from the remainder of the mentally defective population. Light will only be thrown on these possibilities when we have larger normal series investigated, and the so-called mentally defective classed by a variety of characters—temperamental, anthropometric, and pathological—as well as by their general intelligence.

Another method which may possibly throw light on the problem is to consider the Gaussian curve obtained from the tail of the extreme mentally defectives of the mentally defective group. Consider first the tail of this group with  $3\frac{1}{2}$  or more years retardation in mental development, i. e. the series:

-3.45	-3.95	-4.45	-4.95	-5.45	-5.95	-6.45	-6.95
-3.95	-4.45	-4.95	-5.45	-5.95	-6.45	-6.95	-7.45
34	18	13	3	4	4	1	1

<sup>1</sup> There is a point here to which some weight should be given, namely, that no series of tests go beyond 15, thus the exceptionally able *older* children may not be represented by their full mental excesses, as no high series of tests are in use. This curtailing of normal children on the excess side appears also in some data of Goddard's (*The Pedagogical Seminary*, Vol. XVIII, p. 235; *L'Année psychologique*, Tom. XVIII, p. 289). Goddard gives a correlation table and a single-frequency series which should contain the same numbers, but they do not, and appear at other points inconsistent with each other. The single-frequency series runs:

MENTAL EXCESS OF NORMAL CHILDREN.

+4	+3	+2	+1	0	-1	-2	-3	-4	-5	-6	-7	Total.
2	14	49	329	554	312	156	79	37	8	6	1	1547

This shows much the same 'skewness' as the Swedish data, but analysis of the results for each age group shows that children up to 9 have mental excess; from 10 to 15 they have mental defect in increasing magnitude. This either means the absence of the higher age tests, or the marked disappearance of the abler children, or possibly both factors at work. Goddard appears to have investigated the mental defect of the feeble-minded children, but in the only paper that I have been able to see in this country (*The Pedagogical Seminary*, Vol. XVII, pp. 387-97) he does not give the most essential point—the ages of the feeble-minded. It is not possible therefore to judge how far the feeble-minded distribution overlaps the normal distribution. Goddard's mean mental excess,  $-40$  years, and his

The full Gaussian can be readily found by the method proposed, and the tables published by Lee and Pearson.<sup>1</sup> Measured from  $-3.45$  we find:  
Mean of tail  $\nu_1' = 1.8077$  in  $\frac{1}{2}$  year units.  
Standard Deviation  $\Sigma$  of tail is given by  $\Sigma^2 = 2.7258$  in same units.  
Hence in the notation of the paper just referred to:

$$\psi_1 = \Sigma^2/\nu_1'^2 = .834,$$

whence from the Tables there given:

$$h' = 2.186, \quad \psi_2 = 2.833.$$

The constants of the required Gaussian are:

Mean at distant  $h$  from  $-3.45 = h' \times \sigma = 5.597$  yrs.

Standard Deviation  $= \sigma = \nu_1' \times \psi_2 = 2.5606$  yrs.

Thus the mean of the required distribution would be at  $+2.147$  years of mental *excess*, and the variability  $2.561$  years would be extremely large. Further, the total population would be  $N = 78 \div (.01441) = 5413$ , or the tail of extreme mental defectives is only  $1.44$  per cent. of the population corresponding to it. Its mean at  $+2.15$  years of mental *excess* shows that it corresponds to nothing existing in the normal population, unless we argue that extreme ability and extreme stupidity are parts of a homogeneous distribution of intelligence wholly differentiated from the normal population! We can, however, place little trust on the completion of a distribution from a tail of such relatively small frequency. It is worth while putting on record the distributions obtained by taking the tail up to two other and different dichotomies.

TABLE J. DISTRIBUTIONS CORRESPONDING TO DIFFERENT DICHOTOMIES.

	All Defectives beyond $-2.95$ yrs.	All Defectives beyond $-3.45$ yrs.	All Defectives beyond $-3.95$ yrs.
Size of Tail	119	78	44
$\nu_1'$	2.0126 ( $\frac{1}{2}$ yrs.)	1.8077 ( $\frac{1}{2}$ yrs.)	1.8182 ( $\frac{1}{2}$ yrs.)
$\Sigma^2$	2.9893 ( $\frac{1}{2}$ yrs. <sup>2</sup> )	2.7258 ( $\frac{1}{2}$ yrs. <sup>2</sup> )	2.4897 ( $\frac{1}{2}$ yrs. <sup>2</sup> )
$\psi_1$	0.727	0.834	0.753
$\psi_2$	1.934	2.833	2.099
$h$	1.042	2.186	1.263
Total Population	800	5413	426
Mean	$-1.21$ yrs. Defect	$+2.15$ yrs. Excess	$-1.54$ yrs. Defect
Standard Deviation	1.6736 yrs.	2.5606 yrs.	1.9082 yrs.
Rough range ( $\pm 3\sigma$ )	$+3.81$ to $-6.23$	$+9.83$ to $-5.53$	$+4.18$ to $-7.26$

standard deviation,  $1.40$  years, differ considerably from ours. His frequency distribution is of course absolutely inconsistent with a Gaussian curve.

<sup>1</sup> See *Biometrika*, Vol. VI, pp. 65 and 68.

The wide divergences of the three results indicate how small is the approach to a single homogeneous Gaussian in the tail of the mentally defective population. Any attempt to represent it by a Gaussian leads us to a population at least 30 per cent. larger than the observed mentally defective population, and including individuals with an amount of mental excess approaching at least to genius, i. e. something far beyond what we have found in a normal population of children. These are not conclusive arguments in favour of the heterogeneity of the mentally defective population, but taken in conjunction with the extreme 'skewness' of that distribution ( $\beta_1 = \cdot 322$ ), they suggest that the population segregated as mentally defective: (i) consists of at least two continuous components as measured by intelligence, or else (ii) is only itself a selected portion of a population which includes many individuals of considerable mental excess, as well as those of special mental defect. Both suggestions are incompatible with any 'unit character' conception of mental defect.

#### (VI) CONCLUSIONS.

When a series of psychological tests, like the Binet-Simon series, is applied to two populations, the first population selected as one of normal children, and the second one of those segregated in special classes or schools for 'mentally defective' children, we find:

(i) That there exists an absolute continuity of intelligence in the mentally defective group, with an even greater range of variation than occurs in the normal population.

(ii) That the grades of intelligence of the mentally defective children of the special schools largely overlap the grades of normal intelligence. As far as intelligence is concerned, there is no boundary whatever between the normal population and the population of children segregated as 'mentally defective'.

(iii) That no justification whatever can be derived from our data for talking of the mentally defective as lacking a 'factor necessary for full mental development', or speaking of a 'unit character upon which normal development depends', or of feeble-mindedness as due to germ-plasm lacking a unique 'determiner'. All such descriptions are the work of theorists, who have allowed theory wholly to outrun their knowledge, and have dogmatized instead of setting quietly to work and measuring the mental capacity of the children segregated in special schools as mentally deficient. There is no marked dif-

ferentiating line between such children and the normal population. It is a matter of purely practical convenience, where the division—if there must be an arbitrary one—between the normal and defective child is placed; we suggest that it be placed at either 3 or 4 years of mental defect. But as mental defect increases with the age of the mentally defective, the division will be really a function of the child's age. At present the mentally defective child is classified largely by the personal equations of teacher and medical man, and this will not be without danger when segregation has become the law of the land.

(iv) That our data are insufficient to allow us to be at all dogmatic as to whether the normal and mentally defective populations are really homogeneous. A Gaussian distribution of intelligence applied to our normal population, with 1·7 per cent. of the mentally defective added to it, describes the results three times as well as a Gaussian distribution applied only to the 'normal' population. That 'normal' population shows signs of double curtailment such as would arise, if, as is the case, a percentage of the abler children had been drafted from it,<sup>1</sup> as well as the above percentage of mentally defectives. At the same time, we consider, to judge from the distribution of intelligence, that the mentally defective population has not been selected purely by mental defect. These children form a group in which mental defect is very common, but which probably includes also other types of social or school inefficiency, due to traits only by courtesy classed under intelligence, although they may be psychical characteristics.

It appears to us that it would be far better to drop the term mental defectives for these children, and to speak of them broadly as social inefficients. An extensive psychological study based on accurate measurement of a large number of such children should then be made, and such a study should not be confined to intelligence tests; it should deal with moral and temperamental as well as purely mental characters, and it should investigate power of inhibition, power of initiation, extent of conscientiousness and of reliability, &c. Such an investigation would lead to a classification of these social inefficients of far greater value than the present rough categories of high grade and low grade mental defectives, and moral defectives. Only when this has been done will it be possible to study accurately the heredity of so-called feeble-mindedness, and we ought for the present to avoid such crude statements as those to which certain scientists are at the present

<sup>1</sup> Or, given unduly low values owing to faulty tests.

moment giving currency in the public press,<sup>1</sup> and which may be summed up in the sentence, that a perfectly continuous variate—such as mental defect has now been demonstrated to be—is due to the absence of a Mendelian unit character or determiner in the germ-plasm. It is clear that any such assertion must involve the hypothesis that there is some biologically definite line differentiating normal intelligence from mental deficiency, and must further assume that this differentiation is appreciable to the medical man, the school teacher, or the American field-worker. From the standpoint of social reform and legislative interference in this difficult field such dogma is dangerous in the extreme. Mental defect is a continuous variate. Extreme cases are complete social inefficients, moderate cases are undesirable members of the community, but we pass from such cases by continuous grades to all phases of what are termed normal intelligence, even up to the highest grades of ability. Where it is desirable to draw the line and say that here inefficiency is so great that segregation is desirable is purely a matter of social convenience. The eugenicist and the pedagogue would be inclined to take a higher limit than some politicians, who would prefer to stop at no limit above that of an imbecile asylum. But evil will certainly arise if we proclaim in the name of science that mental efficiency is due to a ‘determiner’, and mental deficiency to its absence. Has any one tested yet what progeny result from the mating of various grades of mental excess with various grades of mental defect? Who is to settle whether a child with one year of mental defect belongs to the normal or the feeble-minded population? It is merely matter of personal equation, and pedigrees based on such classifications may demonstrate the general heredity of defective mental power, but can give no basis for Mendelian dogma. What is needed is not idle hypothesis, but unbiased study not only of pedigrees, but of the quantitative measurement of mental faculties by the investigator with adequate psychological training. It is a vast field, but European science will only bring down upon itself the contempt of practical men, if it accepts these vague American results without criticism of method, and without control experiments and observations.

<sup>1</sup> The latest offenders in this respect are Professor Bateson in his Address to the International Medical Congress (see *British Medical Journal*, August 16, 1913, p. 360), and Dr. Leonard Doncaster in his ‘Citizen’ Lecture at the Birmingham Meeting of the British Association (*Times* newspaper, September 15, 1913).

## APPENDIX

### NOTE I. BINET-SIMON TESTS.

(GUSTAV A. JAEGERHOLM.)

THE leading ideas of the Binet-Simon test series for determining mental deficiency are these:

The different phases of intelligence in the normal growth of children are at the same time characteristics of the relative intelligence in individuals of the same age. Higher intelligence means the result of a faster growth of intellectual powers than in the average child; lower intelligence means the result of a slower growth. A child of 7 years old that is considerably more intelligent than the average child of the same physical age resembles the average child of a higher physical age, say 8 or 8·5 years. Mental deficiency consists, according to Binet, first, in a considerable backwardness of mental development, amounting to anything above two years; and secondly, in the existence in mentally defective children of 'un tour spécial' in 'la manière de comprendre, de raisonner, d'imaginer', which is 'difficile à définir, mais qui ne paraît pas avoir son équivalent chez un normal plus jeune, et qui par conséquent ne résulte pas d'un simple retard de développement.'<sup>1</sup> In the test series this second point of view is only indicated by pointing out the importance of the appearance of any such 'tour spécial' during or in the testing, and a general warning must be given not to make the testing or the calculation of any coefficient too mechanical. Further, some tests are included in the series which are of special value in producing 'tours spéciaux', if any exist, e. g. the criticism of absurdities and others.

Binet and Simon have worked out a test series containing five tests for each whole year of life, the physical age being exact to  $\pm 2$  months, and each test for a certain year being such that out of a group of normal children of this physical age the tests will be passed by 65 to

<sup>1</sup> Binet et Simon, *Les enfants anormaux*, Paris, Colin, 1907, p. 21.

90 per cent. German and American authors have generally fixed 75 per cent. as the standard, though as a rule quite arbitrarily. Binet's own calculations of the percentages are statistically of very little worth; in one of his papers he takes percentages of 20 children and asks us to consider these numbers as standards from which to judge our results. Many of the tests are far too difficult, especially at the ages 10 to 15; while others in the groups for 4 to 7 years are mostly too easy. His choice of tests from the psychological standpoint is done with too little care, all sorts of tests—rote-memory, criticism of absurdities, counting backwards from 20 to 0—are mixed together. As almost every intellectual power is growing rather rapidly from year to year, a sufficient number of tests appears to be the first important point, provided there is conformity with the 65 to 90 per cent. principle. The dangers associated with this principle have come very clearly into view in most of the publications on the Binet-Simon method that have recently been published in America.

Every test is counted, there being five tests per year, as .2 intelligence years, and in determining the mental age the same value is given to each irrespective of the year of the test. Thus, say a child of 7.4 years of physical age is tested. It completes:

	Mental Age.
All tests in the 6 years' group :	6 years.
4 tests in the 7 years' group :	0.8 „
2 tests in the 8 years' group :	0.4 „
2 tests in the 9 years' group :	0.4 „
Physical Age 7.4,    Mental Age	7.6.

The child is thus .2 intelligence years ahead. My investigation will be fully described in Stern und Lipmann's *Zeitschrift für angewandte Psychologie*. Here it suffices to say that I have come to the conclusion that the original Binet tests are in several cases almost worthless or wrongly placed, and I had to work out new ones or adapt others. It would be unnecessary here to trouble the reader with detailed descriptions of all the tests used. I merely give a list, and this will suggest their nature. Most of them are tests modified from the Binet-Simon series, and as such are marked B. & S. mod.; totally new tests are marked with an asterisk. My investigations have been continued, and I hope shortly to be in a position to publish an improved and extended series of tests, providing ten tests per year.

The tests used were the following:

Age 6 years.

- (1) Is it fore- or afternoon now?
- (2) Simple definitions (B. & S. mod. according to Bobertag).
- (3) Copy a diamond figure.
- (4) Count thirteen coins.
- (5) Remember three orders.

Age 7 years.

- (1) Compare women's faces on a certain picture and say which you think beautiful.
- (2) Add three 2-öre pieces to three 1-öre pieces.
- (3) Names of colours, blue, green, red, yellow.
- (4)\* Easiest forms of intelligence questions, e. g. If it rained as you went to school, what would you do? &c.
- (5) Find the lines wanting on faces in a certain drawing.

Age 8 years.

- (1) State from memory the differences between butterfly and fly, paper and cardboard, glass and wood, &c.
- (2)\* Give in each case at least four names in one minute of flowers, pieces of furniture, things made of iron, &c.
- (3) Count backwards from 20 to 0.
- (4) Repeat immediately after hearing at least one series out of three, each of five numerals, e.g. 72591.
- (5)\* Add three 10-öre pieces to three 5-öre pieces.

Age 9 years.

- (1) Give change for 20 öre out of 1 crown (=100 öre).
- (2) Intelligence questions. (B. & S. mod.)
- (3) State number of the year.
- (4)\* Give collective names, e.g. of chairs, tables, beds, &c.; several such questions.
- (5) Description of pictures.

Age 10 years.

- (1) Find real order of words in a sentence given in wrong order. (B. & S. mod.)
- (2) Number of words in three minutes (35). (B. & S. mod.)
- (3) Sentence Building I. Three words given and a sentence containing them required. (B. & S. mod.)
- (4) To give names of months in right order.
- (5) To put weights with the same exteriors of 3, 6, 9, 12, and 15 grs. in order from heavier to lightest.

Age 11 years.

- (1) Criticism of absurdities I. (B. & S. mod.)
- (2)\* Differences between concrete words, e. g., dwarf and child, &c.
- (3) Copy from memory geometrical figure I. (B. & S. mod.)
- (4) Ball and Field test. (Terman and Child's).
- (5) Higher definitions.

Age 12 years.

- (1) Copy from memory geometrical figure II. (B. & S. mod.)
- (2) Interpretation of pictures.
- (3) Sentence building II. Four words. (B. & S. mod.)
- (4) Mark number of nouns in three minutes, II. Fifty-five words.  
(B. & S. mod.)
- (5) Hands of clock. (Binet, 1905).

Age 13 years.

- (1) Advanced intelligence questions. (B. & S. mod.)
- (2) Three rhymes to *cat*, or such words.
- (3) Advanced absurdities II. (B. & S. mod.)
- (4) Repetition of seven numerals. (Cf. age 8 (4)).
- (5) Copy from memory geometrical figure III.

Age 14 years.

- (1)\* Interpreting of proverbs.
- (2) Distinction between abstract nouns. (B. & S. mod.)
- (3) Definition of abstract nouns. (B. & S. mod.)
- (4) Sentence building III.
- (5) [No test adopted here at this stage.]

Some of these tests, especially those for ages 11-14 years, were a little more difficult than they ought to have been. I had to take the best tests known to me, and in particular cases the solutions by children of the right age were only 55 per cent. instead of 65 to 90 per cent. The results therefore will naturally be a little too low. 261 normal elementary school children of ages 7 to 14 and 301 mentally defective children were tested with this series, the latter being, with the exception of 10 to 20 not at the time available, all the children in the 'Help Classes' of the Stockholm elementary schools. The investigations were made originally with a view of gauging the difference between extremes. For the normal children from the ages 7 to 10, 25 were taken out of classes of about 30, and the teachers were told to send all sorts. My experience is that women teachers are apt to send the more intelligent rather than the slower children; there is a widespread fear that they

themselves may be made responsible for the intelligence of their pupils, and they are anxious to make a favourable impression on an investigator. The men teachers care less. There is co-education in Swedish elementary schools up to about the age of 10. Out of the higher classes I took from each class of boys and each class of girls the four best, five medium, and the three worst in the teacher's estimate. There is thus a difference in the manner of selection of children up to ten and after. Further, out of 3,000 children of the age of 10 about 200 boys leave the elementary school and go to the 'Vorgymnasia'. But as the percentage of tests for children of 11 and 12 years was calculated on those that remain in the elementary school, this will be of less consequence, even if the children who are transferred to the 'Vorgymnasia' were considerably more intelligent than the remainder.

The mentally deficient children were tested with nearly the same tests as the normal children, with the exception that in the last four years only three tests were used in each group.<sup>1</sup> For these ages each test was then counted as  $= \frac{1}{3}$  year. The results are therefore somewhat more unreliable for the higher mental ages of the mentally deficient.

#### NOTE II. SELECTION OF THE MENTALLY DEFECTIVE.

The term 'social inefficients' has been suggested in this paper as more suitable than 'mental defectives' to describe those children who are drafted into special centres, classes, or schools. It must, however, be remembered that they are in the first place 'school inefficients', a large proportion of whom will later doubtless have to be taken charge of by the state or charitable institutions, i.e. they are the material out of which social inefficients develop. The recent English Act for the segregation of the mentally defective, while largely defining the class it proposes to deal with on the basis of social inefficiency, obviously anticipates that these social inefficients will be chiefly selected, not after experience of social failure, but on the grounds of school experience, i.e. educational inefficiency. There seems every reason to believe that the children in the Swedish 'help-classes' correspond closely to the children in the special schools of this country. The

<sup>1</sup> The omitted tests were : Age 11, 3 and 4 ; Age 12, 3 and 5 ; Age 13, 3 and 4 ; Age 14, 1 and 5.

following account, therefore, of the factors which lead in Sweden to segregation in the 'help-classes' may be of interest to the reader.

Children are rarely sent to these classes directly on account of moral defects. With the exception of 1 to 2 per cent. the children are very docile in a sheep-like sort of way. This is not opposed to the fact that the morality in the 'help-classes' is very low; there is much lying, not so much obstinacy, and the immorality is exhibited rather in sexual matters than in marked anti-social conduct with regard to the community. The main characteristics are general weakness of physique and of mentality.

Very defective health and extremely poor nutrition are also sources of transfer to the 'help-classes'; for example, children are transferred if physically too weak to sit four to five hours a day on the school benches. In such cases the growing custom of feeding the children inexpensively (sometimes only dinner at 1 p.m., but occasionally breakfast at 10 a.m.) has had a very favourable influence. Although special instruction is provided for the deaf, children with deafness, or even bad sight, accompanied by a certain degree of mental backwardness, find their way into the 'help-classes'. Also children with other physical defects, whether congenital or acquired—rickets, epilepsy, nose and throat troubles, &c.—are likely to pass into these classes.

One of the difficulties also in discussion of the class of 'mentally defectives' is the enormous influence of the personal equations of teacher and medical officer on the selection. There is no general rule in the schools that children who cannot progress must be sent to the 'help classes', and no child can be sent without the parents' consent, which will often be persistently refused. Some teachers believe that even the dumbest child will gain nothing from the 'help-classes', and allow it to drag on year by year in the school; and when this is coupled with the idea that a child should not be left behind its fellows, we may find, even in the higher classes of a school, children who ought to be in the 'help-classes'. Again, in the most crowded schools there may be little or no room for 'help-classes', which only have 12 to 18 children, and which replace classes with 35 or even, though rarely, 40 children. In less crowded schools with plenty of room there may be no difficulty at all in organizing 'help-classes'. As the different schools have different medical officers, so the boundary line of normal and defective has been made very different in different schools, the tendency being to put it low down in the crowded schools and higher up in the others. Thus in certain schools, where there is room, a

teacher may press the idea of the 'help-class', with the compliance of the medical officer, to cover a form of education which he or she thinks desirable for somewhat backward children.

Generally it would appear that the Swedish special centres for the 'mentally defective' cover a mass of school inefficients, the particular characteristic of whom is general weakness or degeneracy, physical and mental. The high correlation of these factors of school inefficiency is now well recognized. Pearson found,<sup>1</sup> for children of the professional classes, that the robust individuals among the dull and slow children are below the general percentage, and they rise above it for the able children; conversely, the delicate children are below the general percentage on the intelligent side and rise above it on the dull side. The intelligent children have far more conscientiousness and far less sullen temper than the dull children, while athletic power is much more prevalent where there is greater intelligence. Thus in normal children of the professional classes there is undoubtedly a link between intelligence, morality, and physical health.

Again, 60 normal children of the University of Pennsylvania summer school gave an average mental *excess* of +.48 yrs., but 73 children of the Philadelphia special public school for disciplinary cases gave an average mental *defect* of 1.55 yrs., and 100 delinquent children of the Philadelphia House of Detention gave an average mental *defect* of 2.99 yrs.<sup>2</sup> In all these cases the Binet-Simon tests were used. These results show the close association of intelligence and social delinquency. Dr. Cornell<sup>3</sup> also gives details of the examination of 22 mentally defective children in a first centre and 44 in a second centre of the city of Philadelphia. Of the 44 children examined only 3 passed without noticeable physical defect, and of these 3 one was so backward mentally that physical examination of its sight and hearing were useless. Of the 22 backward children 11 possessed defective vision, 14 adenoids in a marked degree, 5 were markedly deaf or suffered from discharging ears, and 7 showed very poor nutrition. In another school Dr. Cornell<sup>4</sup> studied the percentage of children without physical defects in four classes of the same grade, but made up so as to differentiate the bright from the dull children. The two classes of bright children had respectively 72 and 82 per cent. of children without physical defect, the class of dull children 62.5 per cent., and the class

<sup>1</sup> *Biometrika*, Vol. V, pp. 132-5.

<sup>2</sup> W. S. Cornell, *Health and Medical Inspection of School Children*, 1912, p. 436.

<sup>3</sup> *Loc. cit.*, p. 385.

<sup>4</sup> *Loc. cit.*, p. 389.

of dullest children only 44·8 per cent. Much further evidence could be brought to show the interrelation of mental defect, physical weakness, and social delinquency. It is familiar to every one who has studied the reports of inebriate homes or the characteristics of the criminal.<sup>1</sup> Yet this 'hotch-potch' of physical defect, feeble-mindedness, and social inefficiency, which has been and will now be still further segregated on the basis of 'school inefficiency', is what passes as 'mental defect', and regardless of its graded character when measured by intelligence tests is, we are told, to be thrust into the category of a Mendelian unit character.

#### NOTE III. THE GAUSSIAN CURVE AS APPLIED TO INTELLIGENCE.

There is absolutely no reason why the Gaussian curve should be dogmatically asserted to apply to the frequency-distributions of intelligence, especially when these distributions are based on observations on *growing* children. Still there are *a priori* suggestions that it should be tried. In the first place it does describe with a great degree of accuracy most physical measurements in man, and secondly, the Biometric School has found that it gives good results for many measures of intelligence. It is the view of the psychological joint-author of this paper that its comparative failure as applied to the present data lies rather in faults in the tests applied or in the method of applying them than in the non-Gaussian character of intelligence when adequately measured. He considers that the Binet-Simon values for mental ages have at present to be received in a very critical spirit. In particular he would largely attribute the fault in the present data to too few of the higher tests—even in the lower ages—being given to the children. This absence of the higher age tests, or it may be of the higher age testing, has already been hinted at on p. 34, foot-note, and p. 37. In order to test this point effectively, 100 eight-year-old children were very carefully tested *ad hoc*, and the differences of mental and physical ages fitted with a Gaussian curve. The measure of the 'goodness of fit' was now found to be  $P = \cdot 5$ , or in 50 per cent. of cases random selections from a Gaussian distribution

<sup>1</sup> See for example *Studies of Extreme Alcoholism in Adults*, Eugenics Laboratory Memoirs XIV and XVII (Dulau & Co.), and *The English Convict: A Statistical Study*, by Charles Goring, M.D. (Wyman & Sons).

would have fitted worse than the observed distribution. It would seem likely therefore that, when the Binet-Simon tests are more accurately worked out, and applied with a maximum of caution, the Gaussian curve will be found to describe effectively the distribution of mental excess and defect. We shall then be able to ascertain far more definitely whether the mentally defective children are in the bulk only extreme cases of the general population classed by intelligence. At present all we can say is that the mentally defective children added in their proper proportion to the normal children certainly give a much better approach to the Gaussian than either group taken alone.

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